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AIR QUALITY and METEOROLOGY ENVIRONMENTAL MONITORING PROCEDURES

MONTANA MHD CDIF

The Montana Energy and MHD Research and Development Institute, Inc.

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Butte, Montana 59701

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AIR QUALITY and METEOROLOGY ENVIRONMENTAL MONITORING PROCEDURES

MONTANA MHD CDIF

Draft Interim Progress Report

Prepared by

Air Quality/Meteorology Section
Environmental Engineering Division
Environmental Monitoring--CDIF Support
Montana Energy and MHD Research and Development Institute
P. O. Box 3809
Butte, Montana 59701

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TABLE OF CONTENTS

Page

ABSTRACT. i

BACKGROUND. ii

PART I AIR QUALITY PARAMETERS AND ANALYTICAL PROCEDURES

1.0 TOTAL SUSPENDED PARTICULATES AND TRACE ELEMENTS 1

2.0 SETTLEABLE PARTICULATE. 6

3.0 STATIC AIR SAMPLING 8

4.0 PRECIPITATION WASHOUT 11

5.0 AMBIENT IMPINGER SAMPLER FOR SO_2 AND NO_2. 13

6.0 CONTINUOUS SO_2 AND NO_2 MONITORS 17

7.0 AMBIENT PARTICLE SIZE DISTRIBUTION. 18

8.0 AIR POLLUTION EFFECT ON VEGETATION. 19

APPENDIX A. 21

PART II METEOROLOGY/CLIMATOLOGY PARAMETER AND DATA LOGGING SYSTEM

1.0 WIND SPEED SENSOR 47

2.0 HORIZONTAL WIND DIRECTION SENSOR. 48

3.0 BIVANE WIND SENSOR. 49

4.0 HEATED RAIN/SNOW GAUGE. 50

5.0 BAROMETER SENSOR. 51

6.0 SOLAR RADIATION SENSOR. 52

7.0 TEMPERATURE AND DEW POINT SENSORS 53

8.0 ACOUSTIC RADAR. 54

9.0 ALDEN FACSIMILE RECORDER. 55

10.0 DATA LOGGING SYSTEM 56

PART III-A DATA HANDLING SYSTEM AND COMPUTER INTERFACE

1.0 INTRODUCTION. 58

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TABLE OF CONTENTS (Continued)

Page

2.0 SUMMARY. 58

3.0 PROGRAMS 58

3.1 Input 58

3.2 Verification and Editing. 59

3.3 Input of Data to Permanent Data File. 60

3.3.1 Input of Paxson Station Data 60
3.3.2 Input of Permanent Meteorological Station Data 62

3.4 Reports 62

3.4.1 Output of Paxson Data. 62
3.4.2 Output of Permanent Meteorological Station Data 62

3.5 Data File Manipulation. 63

4.0 DATA FILES 63

4.1 PASXON.DA 63

4.2 PRMET.DA. 63

PART III-B DATA HANDLING SYSTEM AND COMPUTER INTERFACE

1.0 INTRODUCTION 66

2.0 SUMMARY. 66

3.0 FACILITIES 66

4.0 PROGRAMS 66

4.1 Input 66

4.2 Data File Manipulation. 69

5.0 DATA FILES 69

5.1 Dustfall Data File. 70

5.2 High-Volume Air Sampling Data File (Fiberglass Filter) 71

5.3 High-Volume Air Sampling Data File (Whatman #41 Filter) 71

5.4 Precipitation Washout Data File 72

5.5 Static Air Data File. 73

5.6 Ambient Impinger Data File. 73

ABSTRACT

This draft interim report presents the procedures in current use for the MHD CDIF Environmental Monitoring and Evaluation Program encompassing air quality and meteorology/climatology.

Documentation of the environmental monitoring procedures is essential to ensure program continuity and proper interpretation of data. A brief explanation of the existing program is presented in the background section. Section I includes methods, descriptions, calibrations, calculations, and applicable state and federal regulations for all air quality parameters currently being monitored. Appendix A is a compilation of all current laboratory analytical procedures relating to air quality monitoring. Equipment specifications for meteorological instrumentation are presented in Section II along with a brief description of each parameter. The computer interface programs for storage and correlation of data are explained in Section III. Updates or modifications of the document will be introduced when necessitated by the addition of other parameters or the utilization of new methods in the environmental monitoring program.

BACKGROUND

An environmental monitoring and evaluation program encompassing air quality, meteorology, and climatology has been implemented to assure that the operation of the Montana MHD CDIF adheres to applicable environmental regulations and standards. The program will verify the MHD CDIF environmental impacts through documentation and comparison between baseline (pre-operational) and future (operational) environmental parameters.

A permanent meteorological/air quality station, approximately 0.4 kilometers (¼ mile) southeast of the MHD CDIF site, has been established. Meteorological data is monitored at two levels (10 meters and 40 meters) on a 40-meter tower. A mobile air quality/meteorological station is operating 2.4 kilometers (1½ miles) southeast of the CDIF site. All wind sensors are located at ten meters. Establishment of a second mobile satellite station has been initiated, and additional mobile monitoring stations in the CDIF--south Butte area--are planned.

PART I

AIR QUALITY PARAMETERS
and
ANALYTICAL PROCEDURES

1.0 TOTAL SUSPENDED PARTICULATES AND TRACE ELEMENTS

Method: High-volume sampler, General Metal Works, using A/E Gelman fiberglass and Whatman #41 filter media. Total suspended particulates are collected according to Federal Register 40 CFR 50; 41 FR 52686, December 1, 1976 and EPA-R4-73-0286, June 1973.

Description: Twenty-four hour samples are collected every two days to coincide with the six-day national ambient sampling network schedule. The sample rate is preset and maintained at approximately 42.0 SCFM by a Sierra constant flow controller. As a back-up precaution, air flow can be determined by interpreting a chart from a transducer connected to the "hi-vol" back orifice. Operation of the "hi-vol" is regulated by a seven-day clock, and the total sample time is calculated (to the nearest 0.1 minute) from an elapsed-time indicator.

Total Suspended Particulate: The sample is collected on an 8x10 inch type A/E Gelmen Fiberglass filter and is processed according to the procedure in Appendix A. Laboratory results and field data are recorded on high-volume data sheet I (p. for computer entry.

Trace Elements: The sample is collected on an 8x10 inch Whatman #41 filter, which is sectioned and processed according to the analytical procedures in Appendix A. Laboratory results and field data are recorded on high-volume data sheet II (p. for computer entry.

Calibration: A calibration performance check is conducted every two weeks using a standard front orifice. Average flow rates varying greater than three (3.0) percent from 42 SCFM will require readjustment of the constant flow controller.

The standard front orifice is calibrated with a primary standard roots meter at least once per year or when necessary.

Calculations:

Front orifice/back orifice

$$Q_{chart} = Q_{roots} \, (.5425) \left(\frac{P_{roots}}{T_{roots}} \right)^{1/2}$$

$$K_o = \frac{\Sigma \, Q_{chart}}{\Sigma \, (|SP|)^{1/2}} \qquad \text{(calibration constant)}$$

Hi-vol flow rate

$$Q_{SCFM} = K_o \, (.5425) \left[\frac{P_{amb}}{T_{amb}} \, (|SP|) \right]^{1/2}$$

Sample volume

$$SQ_{SCM} = .02832\ (Q_{SCFM})\ \text{(total sample time in minutes)}$$

Total suspended particulates

$$TSP = 1000\ \frac{\text{mg, particulate}}{SQ_{SCM}}$$

Trace elements

$$\text{Trace} = \frac{\mu\text{g, trace element}}{SQ_{SCM}}$$

Where

Q_{chart} = Calibration flow rate (CFM), 1013.2mb Hg; 25°C

Q_{roots} = Actual flow rate from roots meter (CFM)

Q_{SCFM} = Standard flow rate (CFM), 1013.2mb Hg; 25°C

P_{roots} = Absolute pressure roots meter, mb Hg

P_{amb} = Ambient absolute pressure, mb Hg

T_{roots} = Air temperature at roots meter, $^{\circ}$K, assume room temperature. Note: When calibrating the back orifice, error is introduced with this assumption.

T_{amb} = Ambient temperature, $^{\circ}$K

$|SP|$ = Absolute value of front or back orifice static pressure, inches of water column

SQ_{SCM} = Total sample volume, cubic meters, 1013.2mb Hg; 25°C

TSP = Total suspended particulates, $\mu g/m^3$, 1013.2mb Hg; 25°C

Trace = Trace element concentration, $\mu g/m^3$, 1013.2mb Hg; 25°C

Applicable Standards:

Montana

Total Suspended Particulates:

- $75 \mu g/m^3$, annual geometric mean.
- $200 \mu g/m^3$, not to be exceeded more than one percent of days per year

Suspended Sulfate:

- $4 \mu g/m^3$, maximum allowable annual average
- $12 \mu g/m^3$, not to be exceeded over 1.0 percent of the time

Trace Elements: None

Federal

Total Suspended Particulates:

Primary
- $75 \mu g/m^3$, annual geometric mean
- $260 \mu g/m^3$, maximum 24-hour concentration not to be exceeded more than once per year

Secondary
- $60 \mu g/m^3$, annual geometric mean.
- $150 \mu g/m^3$, maximum 24-hour concentration not to be exceeded more than once per year

Suspended Sulfate: None

Trace Elements: None

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AIR QUALITY PROGRAM
DATA SHEET I

High Volume Air Sampling
Fiberglass Filter

Station ID Number ________

Date ________

Filter Number ________

Q_{std} Rate (1013.2mb Hg; 25°C) ________, SCFM

Initial Time (t_i) ________

Final Time (t_f) ________

Total Particulate Weight ________ mg/paper

Comments:

________ ________
Initials Date

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AIR QUALITY PROGRAM
DATA SHEET II

High Volume Air Sampling
Whatman #41 Filter

Station ID Number ____________

Date ____________

Filter Number ____________

Q_{std} Rate (1013.2mb Hg; 25°C) ____________,SCFM

Initial Time (t_i) ____________

Final Time (t_f) ____________

Total Particulate Weight ____________mg/paper

Concentrations of:

Al ____________µg/paper

As ____________µg/paper

B ____________µg/paper

Be ____________µg/paper

Benzene Sol. ____________µg/paper

Bi ____________µg/paper

Ca ____________µg/paper

Cd ____________µg/paper

Cl ____________µg/paper

Co ____________µg/paper

Cr ____________µg/paper

Cu ____________µg/paper

F ____________µg/paper

Fe ____________µg/paper

Hg ____________µg/paper

K ____________µg/paper

Mg ____________µg/paper

Mn ____________µg/paper

Mo ____________µg/paper

Na ____________µg/paper

Ni ____________µg/paper

Pb ____________µg/paper

Sb ____________µg/paper

Se ____________µg/paper

Sn ____________µg/paper

SO_4 ____________µg/paper

V ____________µg/paper

Zn ____________µg/paper

Comments:

____________ Initials ____________ Date

2.0 SETTLEABLE PARTICULATE

Method: Standard ASTM dustfall jar according to ASTM method D, 1739-70.

Description: Settleable particulate is collected by exposing a standard dustfall jar to the ambient environment for a prescribed period of time, normally one month. A level of deionized water is maintained in the jars to prevent re-entrainment of particulate deposition. Reagent-grade methanol is added to the jars during winter months to prevent freezing. The solution's specific gravity is checked every three to five days using a calibrated hydrometer to ensure protection to -44.5°C. Collected particulate is analyzed for solubles, insolubles, and trace elements according to the procedures in Appendix A. Laboratory results and related field data are recorded on dustfall sampling data sheets III (p. for computer entry.

Calibration: The area of the dustfall collection jar is determined.

The hydrometer is calibrated using an aqueous solution of 44 percent methanol by weight (approximately 50 percent by volume).

Calculation: Deposition rates in tons per square mile per 30 days are calculated for total settleable particulate and individual trace elements as follows:

$$D = 156.507(W) \times \frac{30}{N}, \text{ for six-inch ID jar}$$

Where

D = tons/sq. mile/30 days
W = particulate weight in grams
N = number of exposed days

Applicable Standards:

Montana

15 tons total settleable particulate/sq. mile/30 days, 3-month average for residential areas.

30 tons total settleable particulate/sq. mile/30 days, 3-month average for industrial areas.

Federal

None

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AIR QUALITY PROGRAM
DATA SHEET III

Dustfall Sampling

Station ID Number ____________

Sampling Month/Year ____________

Exposure Days ____________

Concentrations of:

Solubles ____________mg/jar

Insolubles ____________mg/jar

Total ____________mg/jar

Concentrations of:

Al ____________µg/jar

As ____________µg/jar

B ____________µg/jar

Be ____________µg/jar

Benzene Sol. ____________µg/jar

Bi ____________µg/jar

Ca ____________µg/jar

Cd ____________µg/jar

Cl ____________µg/jar

Co ____________µg/jar

Cr ____________µg/jar

Cu ____________µg/jar

F ____________µg/jar

Fe ____________µg/jar

Hg ____________µg/jar

K ____________µg/jar

Mg ____________µg/jar

Mn ____________µg/jar

Mo ____________µg/jar

Na ____________µg/jar

Ni ____________µg/jar

Pb ____________µg/jar

Sb ____________µg/jar

Se ____________µg/jar

SO_4 ____________µg/jar

Sn ____________µg/jar

V ____________µg/jar

Zn ____________µg/jar

Comments:

____________ Initials ____________ Date

3.0 STATIC AIR SAMPLING

Methods: Sulfation - Huey sulfation plates using lead peroxide-coated fibrous media, Corning Laboratories Sulfation Method.

Nitration--Nitration plate using triethonolamine-coated fibrous media, Corning Laboratories Nitration Method.

Fluroide--Calcium formate treated paper, Corning Laboratories.

Fluoride--Sodium formate treated paper, Montana State Air Quality Bureau.

Description: Treated papers and plates are exposed to the ambient environment for one month in a Montana Air Quality Bureau-type louvered screened enclosure (9¼" x 12 5/8" x 9¼" H). Huey sulfation plate and Corning nitration plates are both $18 cm^2$ coated media in petri dishes. Calcium formate media consists of treated circular Whatman #2 filter paper approximately 11cm in diameter. Sodium formate paper is a 4.8cm diameter treated Whatman #41 filter paper attached to a petri dish. Exposed papers and plates are analyzed according to the methods in Appendix A. Laboratory results and related field data are recorded on static air sampling data sheet IV (p.) for computer entry.

Calibration: None required.

Calculations: Sulfation Rate:

$$SR = \frac{6.944 \times 10^{-3} [SO_2]}{N}$$

Where

N = exposure days
$[SO_2]$ = $\mu g SO_2$ per plate
SR = Sulfation rate, $mg SO_3/100 cm^2/day$

Nitration Rate:

$$NR = \frac{5.556 \times 10^{-2} [NO_2]}{N}$$

Where

N = exposure days
$[NO_2]$ = $\mu g NO_2$ per plate
NR = Nitration rate, $\mu g NO_2/cm^2/day$

Fluoridation Rate (Calcium formate):

$$F_{ca} = \frac{15.078 \times 10^{-2} [F^-]}{N}$$

Where

$[F^-]$ = µg fluoride per paper
N = exposure days
F_{ca} = fluoridation rate (calcium formate), µgF/cm^2/30 days

Fluoridation Rate (Sodium formate):

$$F_{Na} = \frac{1.658\ [F^-]}{N}$$

Where

$[F^-]$ = µg fluoride per paper
N = exposure days
F_{Na} = fluoridation rate (sodium formate), µgF/cm^2/30 days

Applicable Standards:

Montana

Sulfation--0.25 milligrams SO_3/100cm^2/day, maximum annual average.
0.50 milligrams SO_3/100cm^2/day, maximum for any one-month period.

Fluorides--0.3 micrograms/cm^2/30 days

Nitration--None

Federal

None

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AIR QUALITY PROGRAM
DATA SHEET IV

Static Air Sampling

Station ID Number __________

Sampling Month/Year __________

Exposure Days __________

Concentrations of:

- Total SO_2 __________ µg/plate
- Total NO_2 __________ µg/plate
- Fluoride from Ca Formate __________ µg/plate
- Fluoride of Na Formate __________ µg/plate

Comments:

__________ Initials __________ Date

4.0 PRECIPITATION WASHOUT

Method: Collection of precipitation samples after significant rainfall or snowfall episodes.

Description: The precipitation sampling apparatus consists of 11½ inch ID PVC buckets mounted 6 feet above ground level. The buckets are cleaned thoroughly every two days and rinsed with de-ionized water. Samples are collected as soon after each episode as possible. Field data for each episode along with the laboratory anion-cation analyses are recorded on the precipitation washout sampling data sheet V (p.) for entry to the computer. Laboratory analyses are performed according to the procedures in Appendix A.

Calibration: None

Calculations: None

Applicable Standards: None

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AIR QUALITY PROGRAM
DATA SHEET V

Precipitation Washout Sampling

Station ID Number ____________

Starting Date of Sample Period ____________
Ending Date of Sample Period ____________

Starting Time of Sample Period ____________
Ending Time of Sample Period ____________

Date Sample was Collected ____________
Time Sample was Collected ____________

Field Temperature of Sample ____________ °C
Field pH of Sample ____________

Amount of Precipitation
During Sample Period ____________ inches

Volume of Sample ____________ ml

ION CONCENTRATIONS (ppm)

Acidity	____________	Fe	____________
Al	____________	K	____________
As	____________	Mn	____________
Ca	____________	Na	____________
Cd	____________	Ni	____________
Cl	____________	NO_3	____________
Co	____________	Pb	____________
Cu	____________	PO_4	____________
F	____________	SO_4	____________
		Zn	____________

Comments:

____________ Initials ________ Date

5.0 AMBIENT IMPINGER SAMPLER FOR SO_2 AND NO_2

Method: Three gas samplers, Research Appliance Co. Suitable absorbing solutions are used for testing the ambient concentrations for SO_2 and NO_2. The SO_2 method conforms to the Federal Register, 40CFR50; 41FR52686, December 1, 1976, Appendix A. The NO_2 methods conform to EPA-650/4-74-005p, March 1976 and the Montana Air Quality Bureau procedure AQ-NOO-1, March 1976.

Description: Twenty-four hour samples for ambient SO_2 and NO_2 are collected using standard absorbing solutions in 50ml impingers. The flow rate is regulated at about 200cc/minute, using a critical/limiting precision-bore glass orifice. Critical flow is assured by maintaining an absolute pressure downstream from the orifice of less than 50 percent of the ambient absolute barometric pressure. The sample train is regulated by a seven-day clock, and total sample time is determined by an elapsed time indicator (to the nearest 0.1 minute). Exposed impingers with the critical orifice are returned to the laboratory for analysis according to the procedures in Appendix A. Laboratory results and field data are recorded on impinger/sampling data sheet VI (p.   ) for computer entry.

Calibration: The critical orifices are calibrated before and after each 24-hour sample run using a calibrated bubble meter or mass flow meter. System leaks are checked by recording the ball height of a calibrated flow meter before and after each sample run.

Calculations:

Critical orifice

$$Q_{chart} = Q_{cal}(.5425)\left(\frac{P_{cal}}{T_{cal}}\right)^{\frac{1}{2}}$$

Orifice flow rate, sample conditions

$$Q_{SLM} = \overline{Q}_{chart}\ (.5425)\left(\frac{\overline{P}_{amb}}{\overline{T}_{amb}}\right)^{\frac{1}{2}}$$

Total volume sampled

$$SQ_{SCM} = (Q_{SLM} \times 10^{-3})\ (\text{Total sample time in minutes})$$

where,

Q_{chart} = Calibration critical flow rate in liters/minute. The mean Q_{chart} is calculated from calibrated values before and after each sample run.

Q_{cal} = Actual flow rate from bubble or mass flow meter in liters/minute.

P_{cal} = Absolute barometric pressure at calibration, mb Hg.

$\overline{P}_{amb}$ = Mean absolute barometric during sample run, mb Hg.

T_{cal} = Absolute ambient temperature at calibration, ^{o}K.

$\overline{T}_{amb}$ = Mean absolute ambient temperature during sample run, ^{o}K.

Q_{SLM} = Standard sample flow rate, in liters/minute, 1013.2 mb Hg; $25^{o}C$.

SQ_{SCM} = Total sample volume in cubic meters, 1013.2 mb Hg; $25^{o}C$.

SO_2 Concentration

$$SO_2\text{, ppm} = \frac{(\text{mg } SO_2\text{, sample})\ (3.82 \times 10^{-4})}{(\overline{SQ}_{SCM})}$$

NO_2 Concentration

$$NO_2\text{, ppm} = \frac{(\text{mg } NO_2\text{, sample})\ (5.32 \times 10^{-4})}{(\overline{SQ}_{SCM})\ (.82)}$$

where,

$\overline{SQ}_{SCM}$ = Mean sample volume, calculated from orifice calibration before and after sample run.

.82 = Collection efficiency

Applicable Standards:

Montana

SO_2: 0.10 ppm, 24-hour average not to be exceeded more than 1.0 percent of the days in any three-month period.

0.02 ppm, maximum annual average.

NO_2: None

Federal

Primary SO_2: 0.03 ppm, annual arithmetic mean.

0.14 ppm, maximum 24-hour concentration, not to be exceeded more than once per year.

NO_2: 0.05 ppm, annual arithmetic mean.

Secondary SO_2: 0.5 ppm, maximum three-hour concentration, not to be exceeded more than once per year.

NO_2: 0.05 ppm, annual arithmetic mean.

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AIR QUALITY PROGRAM
DATA SHEET VI

Impingers Sampling

Station ID Number ____________

Sampling Date ____________

Impinger Number ____________

Orifice Number ____________

Average Barometric Pressure ____________ mb Hg

Average Temperature ____________ °C

$\overline{Q}_{chart}$, Flow Rate (1013.2 mb Hg; 25°C) ____________ SLM

Initial Time (t_i) ____________

Final Time (t_f) ____________

Rotometer Ball Height Before ____________

Rotometer Ball Height After ____________

Concentrations of:

Total SO_2 ____________ μg/exposed sample

Total NO_2 ____________ μg/exposed sample

Comments:

____________ Initials ____________ Date

6.0 CONTINUOUS SO_2 AND NO_x MONITORS

Methods: Pulsed fluorescent SO_2 gas analyzer.

Chemiluminescent NO-NO_2-NO_x gas analyzer.

Description: A Thermo-Electron Model 43 pulsed fluorescent SO_2 ambient air analyzer will be used to monitor for ambient sulfur dioxide. The instrument certification number is EQSA-0276-009 for equivalency to EPA performance specifications, Federal Register, 40 CFR 53; 40 FR 7049, February 18, 1975, paragraph 53.20 (a) SO_2.

A Thermo-Electron Model 14B chemiluminescent gas analyzer will be used to monitor ambient NO, NO_2, and NO_x concentrations in accordance with EPA specifications, Federal Register, 40CFR50; 41FR52686, December 1, 1976, Appendix F.

Calibration: Calibration procedures are being developed.

Calculations: Data logging and computer interface are being designed.

Applicable Standards:

Montana

SO_2: 0.02 ppm, maximum annual average.

0.10 ppm, 24-hour average not to be exceeded more than 1.0 percent of the days in any three-month period.

0.25 ppm, not to be exceeded for more than 1.0 hour in any four consecutive days.

NO_2: None

Federal

Primary SO_2: 0.03 ppm, annual arithmetic mean.

0.14 ppm, maximum 24-hour concentration not to be exceeded more than once per year.

NO_2: 0.05 ppm, annual arithmetic mean.

Secondary SO_2: 0.50 ppm, maximum three-hour concentration not to be exceeded more than once per year.

NO_2: 0.05 ppm, annual arithmetic mean.

7.0 AMBIENT PARTICLE SIZE DISTRIBUTION

Method: Lundgren type impactor for ambient aerodynamic particle sizing.

Description: A Sierra Model 4220A Lundgren-type impactor is used to fractionate suspended particulate matter in ambient air for subsequent analyses. The unit consists of four stages and a backup filter. Particulate matter is sized aerodynamically in approximately the following fractions:

>10 microns -- Stage 1
3-10 microns -- Stage 2
1-3 microns -- Stage 3
.3-1 microns -- Stage 4
<.3 microns -- Backup filter

Calibration: Will be initiated when all equipment is received.

Calculations: Will be initiated when all equipment is received.

Applicable Standards: None

8.0 AIR POLLUTION EFFECT ON VEGETATION

Method: Infrared and real color photographs of selected sites.

Description: The system consists of two 35mm Olympus cameras mounted on a common bracket. A dual cable release is provided to enable simultaneous exposures in real and infrared (false) color of the same scene. Both cameras were equipped with a Zuiko Automatic 35mm, F2.8 lense incorporating a haze filter for the color film and a No. 12 yellow filter for the infrared film. Kodak Ektachrome infrared film is used in one camera, and Kodachrome 64 color film is used in the other camera.

Fly-overs are conducted during the growing season of each year. Photographs are taken of the following areas:

a) CDIF (looking east)

    Sand Creek/Little Basin Creek

b) East Ridge (looking east)

    Old Columbia Gardens

    Mode-S Canyon/Continental Drive Interchange

    Lucky Strike Gulch--Northern Pacific Railroad Trestle

    Ueland Ranch/Homestake Pass

c) Highlands (looking south)

    Janney/Chicago, Milwaukee, St. Paul, and Pacific Railroad

    Lions Camp

d) West of CDIF (looking west)

    Middle Fork of Little Basin Creek

e) North of CDIF (looking north)

    Timber Butte

    Mountain View Cemetery

    Country Club/Evel Knievel Residence

The infrared and real color slides provide realistic vegetative baseline records.

Calibration: None

Calculations: None

Applicable Standards: None

APPENDIX A

Laboratory Analytical Procedures
Air Quality Parameters
Montana Tech Alumni Foundation
Mineral Research Center, Butte, Montana

APPENDIX TABLE OF CONTENTS

Page

ACIDITY A-1

CHLORIDES A-2

DUSTFALL A-3

FLUORIDE A-5

FLUORIDE A-6

FLUORIDE A-7

FLUORIDE A-8

FLUORIDE A-9

NITRATE A-10

NITROGEN DIOXIDE A-11

NITROGEN DIOXIDE A-13

PARTICULATE WEIGHT A-14

PHOSPHATE A-15

PHOSPHATE A-16

pH A-17

SULFATE A-18

SULFATE A-19

SULFATE A-20

SULFATE A-21

TRACE METALS A-22

TRACE METALS A-23

ACIDITY

METHOD: Hydroxylion.

REAGENTS: 0.0248 N NaOH: Dilute 2N NaOH with carbon-dioxide free water to 1 liter. Standardize NaOH with potassium acid phthalate (KHP). Weigh out aliquots of KHP reading scale to nearest milligram. (Do in triplicate--then average normality.) Add a few drops of phenolphthalein indicator and titrate with NaOH to first permanent pink end-point.

PROCEDURE: Pipette a 50 ml aliquot of sample into a 150 ml beaker. Avoid disturbing any sediment in sample and DO NOT FILTER. Insert pH electrode into the sample, and record pH. Using a magnetic stirring apparatus, slowly add NaOH from a burette to the sample until the pH meter displays a 5.7 pH reading. Record reading of titre. Continue titration to an 8.3 pH reading and record titre.

CALCULATIONS: ml_b = ml of titre, ml_s = ml of sample, N_b = normality of NaOH,

$$\frac{ml_b}{ml_s} \times N_b \times 10^3 \times 1.008 = \text{ Mg/l Acidity as } H^+.$$

$$\text{Normality of NaOH} = \frac{\text{mg. of KHP} \times 4.8964}{\text{ml NaOH}}$$

REFERENCES:

1. Methods for Collection and Analysis of Water Samples for Dissolved Minerals and Gases, Book 5, Chapter A-1. pp. 41.
2. Carrow, D., 1962, Geochemistry of Water: Geological Survey Water-Supply Paper 1535G, p. G-9.
3. Gallow, et al, Acid Precipitation in the Northeastern United States: pH and Acidity, Science, Vol. 194, November 12, 1976, pp. 722-724.

CHLORIDES

METHOD: Mercuric Nitrate

REAGENTS: Mercuric Nitrate Titrant, 0.014N

Dissolve 2.3 gms. Hg $(NO_3)_2$ in 100 ml distilled water containing 0.25 ml conc. HNO_3. Dilute to just under a liter.

Indicator-Acidifier Reagent

Place 100 ml isopropyl alcohol or ethyl alcohol in a 150 ml beaker. Then in order add:

0.25 grams 2-diphenylcarbazone
4.0 ml conc. HNO_3
0.03 grams xylene cyanol FF

Store in a brown bottle, refrigerate when not in use. Replace solution monthly.

Standard Sodium Chloride

Dissolve 0.8241 grams NaCl (dried for 2 hours @ 140°C) in distilled water. Dilute to 1000 ml 1.00 = 0.500 mg CI-.

STANDARDIZATION: Mercuric Nitrate

To 10 ml Standard Sodium Chloride add 90 ml distilled water. One ml Indicator-Acidifier and adjust pH to 3.0 to 3.6. Titrate to purple end-point. Record ml titrant. Adjust mercuric nitrate solution so 1 ml = mg CI-.

PROCEDURE: Place 100 ml sample into 150 ml porcelain casserole. Add 1 ml Indicator-Acidifier. Adjust pH of sample with 1N NaOH or 1N HNO_3 to read between 3.00 to 3.6 titrate sample with mercuric nitrate and record. (A set of Blanks and Standards should be done on each testing. If blank exceeds .50 ml-Indicator-Acidifier is deteriorated - replace).

CALCULATIONS: T = titration, B = blank, S = ml of sample used, F = dilution or concentration factor.

100/s x (T-B) x 5 x F = mg/CI-.

REFERENCES: Methods for collection and Analysis of Water Samples for Dissolved Minerals and Gasses. Book 5 Chapter A-1, pp. 71-72.

Standard Methods for the Examination of Water and Wastewater. 14th Edition, 1975, pp. 304-306.

DUSTFALL

ANALYSIS: Insoluble and Soluble Particulate, Trace Metals.

PROCEDURE: The sample is identified and logged in the manual labeled "Dustfall". Labels from jar should be removed and placed to the right of the page that the analytical data is to be recorded in.

The solution contained in the jar is quantitatively transferred through a seive (cheese-cloth or Handy-Wipes) - note volume; if greater than 250 mls evaporate and return to a volumetric of 250 mls with distilled water.

Metals

Mix sample thoroughly and remove two 50 ml volumes to clean glass beakers. Add 5 mls conc. HNO_3 to each sample and evaporate to less than 25 mls and filter sample thru Whatman #2, into a 25 ml volumetric. Return to volume with distilled water. Sample is then analyzed on the atomic absorbtion unit, using known standards.

CALCULATIONS: Metals

ppm reading ÷ 2 x 250 = ug's of metal/unit jar.

Insoluble Particulate

The remaining 150 ml of sample is filtered through a preweighted 4.25 cm. Glass Fibre Filter. The filter is then placed on a clean watch glass and dried one hour in an oven set @ 100-105°C. Filter is then dessicated for 2 hours and re-weighed. Record weight and dessicate filter overnight and re-weigh record weight in manual. This net weight is the insoluble particulate.

CALCULATIONS: Insoluble Particulate

Weight difference x 1.66 = ug's/unit jar

$$(1.66 = \frac{250}{150})$$

Soluble Particulate

To a pre-weighted beaker, place a 50 ml. aliquot of remaining sample. Evaporate sample in an oven set @ 100-105°C-beaker is then dessicated to coolness and re-weighted. Record weight in log book.

CALCULATIONS: Soluble Particulate

Weight difference x 5 = ug's/unit jar.

$$(5 = \frac{250}{50})$$

REFERENCES:

1. American Society for Testing and Materials, pp. 425-428.
2. Annual Book of ASTM Standards, Part 23.
3. Annual Book of ASTM Standards, Part 10.
4. Standard Conditions, 1976 Perkin-Elmer, Analytical Methods for Atomic Absorption Spectrophotometry.
5. Operating Parameters, 1973 Perkin-Elmer, Analytical Methods Using H-GA Graphite Furnace.

FLUORIDE

METHOD: Ionalyzer-Specific Ion Electrode

REAGENTS: TISAB III, available commercially from Orion (94-09-11). Ionic strength is concentrated to respond on a 10 + 1 addition.

Stock Fluoride Solution

Dissolve 0.2218 g anhydrous sodium fluoride in distilled water and dilute to 1 liter. 1.00 ml = 0.100 mg F^- or 100 ppm F^-. Store solution in plastic bottle. Dilute standards according to needs of test. 10 ppm to .01 ppm F^-.

EQUIPMENT: Fluoride electrode - Orin model 94-09.

Expanded-scale pH meter or selected ion-meter calibrated to read millivolts.

Magnetic-stirring apparatus.

REFERENCES: Standard Methods for the Examination of Water and Wastewater. 14th Edition, 1975 pp 391-393.

Orion Ionalyzer-Instruction Manual-Fluoride Electrodes-Model 94-09 Model 96-09.

FLUORIDE

METHOD: Calcium Formate Papers

PROCEDURE: Remove exposed papers from dessicator and place in plastic beakers. Saturate with 20 mls distilled water. Allow to stand 2 hours. Pipet 2 ml of TISAB III to sample and add magnetic stirring bar. Place beaker on stirring apparatus and set electrode into the solution. Set meter to read millivolt measurement and set magnetic stirrer in operation. When stability is maintained - read millivolt measurement and record.

CALCULATIONS: Plot the potential measurement of fluoride standards versus concentration, on semi-logarithmic graph paper. Lowest concentration at the bottom of the graph. Depict unknowns from standard curve.

PPM F^- x dilution = ug's of F^- per exposed paper.

REFERENCES: Air Pollution Control, Montana State Board of Health, Regulation 90-017, pp. 1-2.

FLUORIDE

METHOD: Hi-Volume Air Samples-Whatman #41

REAGENTS: Refer to Fluoride, Ionalyzer-Specific Ion Electrode (p. A-5)

EQUIPMENT: Refer to Fluoride, Ionalyzer-Specific Ion Electrode (p. A-5)

PROCEDURE: The exposed sample is cut into 1/3's or halfed, depending on request of analysis. The sample is placed in a plastic beaker and saturated with 20 mls distilled water. Allow to stand for 2 hours. Pipet 2 mls TISAB III to sample and add a magnetic stirring bar. Place beaker on stirring apparatus and set electrode into the solution. Set meter to read millivolt measurement and set magnetic stirrer in operation. When stability is maintained - read millivolt measurement and record.

CALCULATIONS: Plot the potential measurement of fluoride standards versus concentration, on semi-logarithmetic graph paper. Depict unknowns from the standard curve.

REFERENCES: Standard Methods for the Examination of Water and Wastewater. 14th Edition, 1975 pp. 391-393.

Orion Ionalyzer-Instruction Manual - Fluoride Electrodes - Model 94-09, Model 96-09.

FLUORIDE

METHOD: Precipation Samples or Water Samples

REAGENTS: Refer to Fluoride, Ionalyzer-Specific Ion Electrode (p. A-5)

EQUIPMENT: Refer to Fluoride, Ionalyzer-Specific Ion Electrode (p. A-5)

PROCEDURE: Place 20 ml of sample in a plastic beaker. Add 2 mls TISAB III to sample and a magnetic stirring bar. Place beaker on stirring apparatus and set electrode in solution. Set meter to read millivolt measurement and set magnetic stirrer in operation. When stability is maintained - read millivolt measurement and record.

CALCULATIONS: Plot the potential measurement of fluoride standards versus concentration on semi-logarithmetic graph paper. Depict unknowns from standard curve.

REFERENCES: Standard Methods for the Examinations of Water and Wastewater. 14th Edition, 1975 pp 391-393.

Orion Ionalyzer-Instruction Manual - Fluoride Electrode - Model 94-09, Model 96-09.

FLUORIDE

METHOD: Sodium Formate Paper

REAGENTS: 50 percent ethyl alcohol containing 10 percent sodium formate to 250 mls distilled water, add 25 mls ethyl alcohol and 50 mls, 10 percent sodium formate.

Petri Dishes - disposable - 48 x 8.5 cm.

Whatman #41 Filter Papers.

PROCEDURE: Whatman #41 filter paper (4.8 cm diameter) is immersed in Alcoholic Sodium Formate. Place on a clean, fluoride free watch glass, and place in a drying oven. Three drops of acetone are placed in the bottom of a clean petri dish and the dried formate paper is adhered with the solution. Replace cover on dish and store in a dessicator until ready for exposure.

When paper is returned to dessicator after exposure, analyze according to Calcium Formate Procedure.

REFERENCES: Air Pollution Control, Montana State Board of Health, Regulation 90-017, pp. 1-2.

NITRATE

METHOD: Modified Brucine

REAGENTS: Concentrated Sulfuric Acid

Brucine: Dissolve 1 gram brucine sulfate and 0.10 gram sulfanilic acid in about 70 mls hot distilled water. Transfer to 100 ml volumetric - add 3 mls concentrated Hydrochloric Acid and dilute to volume. CAUTION!! TOXIC SUBSTANCE. Store in refrigerator when not in use.

PROCEDURE: Align test tubes in numerical order.

Example: 1-Reagent Blank
2-.5 ppm NO_3
3-1.0 ppm NO_3

To the blank add 10 mls distilled water, to standards and samples use 10 ml aliquots. With a burette and 5 mls concentrated H_2SO_4 mix well by swirling tube. Add .5 mls brucine reagent - mix. Add an additional 5 mls concentrated H_2SO_4 and mix thoroughly. Allow color to develop for 5-10 minutes. Cool in water bath. Read absorbance @ 310 nm on spectrophotometer, setting machine on .000 with reagent blank.

CALCULATIONS: Plot on linear graph paper, value of standards versus absorbance of standards. Read NO_3 values of samples from plotted graph. NO_3 values are reported in ppm of NO_3.

REFERENCES: Collection and Analysis of Water Samples for Dissolved Minerals and Gases. Book 5 - A-1 pp 119-121.

Standard Methods for the Examination of Water and Wastewater. 14th Edition, 1975, pp 427-429.

NITROGEN DIOXIDE

METHOD: Colorimetric Spectronic - Nitration Plates

REAGENTS:

Hydrogen Peroxide Solution

Dilute 0.2 ml of 30 percent H_2O_2 to 250 mls with distilled water. Prepare fresh for each testing.

Sulfanilamide Solution

Dissolve 2.0 grams sulfanilamide in 50 mls of distilled water. Add 5 mls of concentrated phosphoric acid, mix well, and dilute to 100 ml with distilled water. Solution is stable for a month if refrigerated.

NEDA Solution

Dissolve 0.1 gram of N-1-naphthylethylenediamine dihydrochloride in 100 ml distilled water. This solution is stable for a month if refrigerated.

Sodium Nitrate Solution

Dissolve 0.1500 grams of reagent grade sodium nitrate in distilled water and dilute to a liter. This solution contains 100 ppm NO_2/ml. The stock solution is stable 6 months @ room temperature.

PROCEDURE: Using a spatula and stream of distilled water quantitatively remove the triethanolamine coating and as much of the fibrous media as necessary from the plate to a clean 250 ml beaker. Place in drying oven 1/2 hour or until sample is less than 15 mls. Filter through a Whatman #2 into a 25 ml volumetric. Dilute to volume with distilled water. Pipette 10 ml of filtered sample into an appropriate test tube and add 1 ml Hydrogen Peroxide Solution, 10 ml of Sulfanilamide Solution and 1.5 mls of NEDA Solution, mixing thoroughly after each addition of reagent. Allow a 10 minute color development time and transfer to a curvette. Read on Spec. @ 540 nm. Set machine on .000 optical density with a prepared reagent blank.

Standard Curve

Dilute 10 mls of nitrate standard to 500 mls with distilled water. This solution contains 2 ppm NO_2/ml. To a series of test tubes add 1, 2, 3, 4, and 5 mls of the dilute NO_2 standard. Dilute each standard to 10 mls with distilled water. Plot on graph paper the nitrate content per standard (2, 4, 6, 8, and 10 ppm) versus optical density. Depict unknowns from graph.

CALCULATIONS: ppm of sample x dilution = ug's of NO_2/exposed plate.

REFERENCES:

1. Corning Laboratories Inc., "Procedure for Analyzing the Nitrogen Dioxide Content in Nitration Plates."
2. Guidelines for Development of Quality Assurance Program; Vol. XVI. Method Determination of Nitrogen Dioxide in the Atmosphere, 1976, EPA-650/4-74-005p.

NITROGEN DIOXIDE

METHOD: Colorimetric Spectronic - Nitration Impingers

REAGENTS: Refer to Nitrogen Dioxide, Nitration Plates

PROCEDURE: Upon return of the impinger sample, measure and record volume of sample in log-book. Refrigerate sample until ready to test. Refer to Nitrogen Dioxide, Nitration Plates, begin with PROCEDURE.

CALCULATIONS: ppm of sample x volume of sample = ug's of NO_2/sample.

REFERENCES: "Guidelines for Development of a Quality Assurance Program: Vol. XVI, Method for the Determination of Nitrogen Dioxide in the Atmosphere, 1976, EPA-650/4-74-005p.

PARTICULATE WEIGHT

METHOD: Fibre-Glass Filters-Gelman, Type A-E

PROCEDURE: Assign a serial number to each filter and record number in log-book. Filter is placed between clean sheets of typing paper, and dessicated overnight. The next morning each paper is weighted and weight is recorded next to the appropriate serial number in log-book. Return to dessicator and the following A.M. repeat procedure.

On return to the laboratory - filter is dessicated over -nite and weighted the following A.M. - redessicate and repeat weighing the next day. Both weights are recorded and the difference in the tared weight is the particulate weight.

REFERENCES:

1. EPA, June 1973, Guidelines for Development of a Quality Assurance Program, EPA-R4-73-028b, NTIS PB-223-051.
2. National Primary and Secondary Ambient Air Quality Standards, Federal Register, 4DCFR50; 41FR52686, December 1, 1976.

PHOSPHATE

METHOD Stannous Chloride

REAGENTS:

Strong Acid Solution

Add 300 mls Sulfuric Acid to about 600 mls distilled water. (Beaker should be immersed in a cold water bath-pour acid slowly with constant stirring.) When solution cools, add 4.0 mls concentrated Nitric Acid and dilute to 1 liter. Store in a glass bottle.

Ammonium Molybdate Reagent

Solution A: Dissolve 25 grams $(NH_4)_6Mo_7O_{24} \cdot 4H_2O$ in 175 mls distilled water. Heat to dissolve.
Solution B: To 400 mls distilled water slowly add 280 mls. concentrated Sulfuric Acid. Cool.
Combine solution A and B-Dilute to 1 liter with distilled water. (Primary Reagent #1)

Primary Reagent #2

Dissolve 40.1 grams $(NH_4)_6 Mo_7 O_{24} \cdot 4H_2O$ in 500 mls distilled water. Heat to dissolve. Cool.

Working Reagent

To Primary Reagent #2, slowly add 396 mls of Primary Reagent #1. Cool. Dilute to 1 liter with distilled water.

Alcoholic Sulfuric Acid Solution

CAUTIOUSLY add 20 mls concentrated Sulfuric Acid to 980 mls of methyl alcohol with continuous mixing.

Stannous Chloride Reagent

Dissolve 2.5 grams $SnCl_2 \cdot 2H_2O$ in 100 mls glycerol. Heat in water bath stirring with a glass rod. This solution is stable and should be stored in a refrigerator.

Dilute Stannous Chloride Solution

Mix 8 mls stannous chloride with 50 mls glycerol. This reagent is stable for 6 months. Store in brown bottle and refrigerate.

Standard Phosphate Solution

Dissolve 0.7165 grams anhydrous potassium dihydrogen phosphate (KH_2PO_4) and dilute to 1 liter.
Stock solution = 500 ppm PO_4/ml KH_2PO_4.
Standards of .05 ppm to .5 ppm should be prepared fresh prior to test.

REAGENTS: continued

Solvent

Mix equal volumes of benzene and isobutanol alcohol. CAUTION: Flammable. Prepare enough for just the immediate test. Discard any amount that is additional.

PROCEDURE: Pipette 50 mls of sample into a 125 separatory funnel. Add (by pipette) 50 mls solvent, and 15 mls molybdate reagent-stopper at once and shake for 15 seconds. Allow the phases to separate and drain off the aqueous layer. The organic layer is placed into a 100 ml volumetric flask. Add 30 mls. Alcoholic Acid -mix- add 1 ml Dilute Stannous Chloride (20 drops standard eye dropper)-mix-dilute sample to volume mark with Alcoholic Acid. Allow to stand 10-30 minutes. Read absorbance at 650 nm - setting machine on .000 with blank reagent. Read absorbance of standards and samples.

NOTE: Sample, standards, and reagents should be within 2°C of one another and in the temperature range between 20° and 30°C.

CALCULATIONS: Plot absorbance of standards versus values of standards. Read PO_4 values of samples from plotted graph. Results are reported in ppm PO_4.

REFERENCES: Standard Methods for the Examination of Water and Wastewater, 14th Edition, 1975, pp 479-480.

P_h

METHOD: Instrument - hydrogen electrode

REAGENTS: Standard Buffer Solutions, pH 4.00, 7.00, 10.00. These are available commercially, ready for use.

PROCEDURE: Standardize instrument according to "Operating Procedure Manual." Temperature of buffers and sample must be the same. If not, temperature compensator on the instrument must be the same. If not, temperature compensator on the instrument must be reset, according to "Operating Procedure Manual." Glass electrode should be immersed in water when not in use. Rinse electrode, shake dry CAREFULLY, immerse electrode in sample and agitate sufficiently to provide homogeneity, and to keep solids in suspension. When stabilized, note pH on meter and record.

REFERENCES: Standard Methods for the Examination of Water and Wastewater. 14th Edition, 1975, pp. 460-465.

Methods for Collection and Analysis of Water Samples for Dissolved Minerals and Gases. Book 5 - Chapter A-1, pp. 129-130.

SULFATE

METHOD: Thorin

REAGENTS: Barium Chloride Titre

Dissolve 0.43 grams anhydrous $BaCl_2$ in distilled water and dilute to 1 liter. 1.00 ml = 0.20 mg SO_4.

Sulfate Standard Solution

Dissolve 1.4787 grams Na_2SO_4 in distilled water and dilute to 1 liter. 1.00 ml = mg SO_4.

Solvent - Indicator Solution

Dissolve 0.025 grams Thorin and 0.5 grams anhydrous sodium acetate in 10 mls distilled water - (beaker should be immersed in hot water bath and swirled slowly to dissolve reagents). Filter the solution through a Whatman #1 filter paper into 1 liter anhydrous alcohol and discard filter paper without cashing or rinsing. All 12 mls glacial acetic acid and mix. Can be stored in a bottle and should precipitation occur, filter through Whatman #2 before using.

PROCEDURE: Pipette a 15 ml aliquot into a 250 beaker, sample pH should be established between 3.8 to 4.2 with .001 percent HCl or .001 percent NaOH. (A blank of distilled water and set value of standards should be included during each procedure.) Sample is then added to a 100 ml curvette and 60 mls solvent-indicator is used to rinse the beaker, then added to the curvette. The curvette should contain a magnetic stirring bar to insure mixing of the sample, thorin, and addition of titre. Spectrophotometer is set @ 520 nm and on placing the curvette in position, set absorbance to read 0.100 with stirring apparatus in operation. Titrate sample with $BaCl_2$ titre until absorbance needle reads 0.200 and is stable for 30 seconds. Record mls of titre used to reach stable end-point.

CALCULATIONS: T = titration, B = blank, S = ml of sample used, F = dilution or concentration.

$$\frac{(\text{ppm of Std. x S})}{(\text{T-B})} \times \frac{(\text{T-B of sample})}{(\text{S})} \times F = \text{ug's of } SO_4.$$

REFERENCES: Methods for Collection and Analysis of Water Samples for Dissolved Minerals and Gases. Book 5 Chapter A-1, pp. 152-154.

SULFATE

METHOD: Hi-Volume Air Sample

REAGENTS: Sodium Carbonate Solution

Dissolve 50 grams anhydrous Na_2CO_3 (AGS Grade) with distilled water to 1 liter.

PROCEDURE: The exposed sample is cut into 1/3's or half's - depending on request of analysis. The sample is then placed in a clean glass beaker and 20 mls of Na_2CO_3 is added, followed by an additional 80 mls distilled water. With a glass stirring rod, tear sample into smaller pieces so as to expose all surface area to Na_2CO_3. The beaker is then placed in a drying oven and evaporated to less than 20 mls. The sample is then filtered through a Whatman #2 into a 50 ml volumetric, dilute to volume with distilled water. Exchange sample twice through clean cation resin.

Refer to Thorin Method and begin with PROCEDURE.

CALCULATIONS:

$$\frac{\text{(ppm of Std x aliquot)}}{\text{ml of } BaCl_2 \text{ - Blk}} \times \frac{\text{(ml } BaCl_2 \text{ - Blk for sample)}}{\text{aliquot of sample}} = \text{ug's/ml } SO_4$$

$$\text{ug's/ml } SO_4 \times \underset{\text{(volumetric used)}}{\text{dilution}} \times \text{portion of paper used} = \text{ug's } SO_4\text{/paper.}$$

REFERENCES: Methods for Collection and Analysis of Water Samples for Dissolved Minerals and Gases. Book 5 Chapter A-1, pp. 152-154.

SULFATE

METHOD: Huey Sulfation Plate

REAGENTS: Sodium Carbonate Solution

Dissolve 50 grams anhydrous Na_2CO_3 (AGS Grade) with distilled water to 1 liter.

PROCEDURE: Using a stream of distilled water and a spatula, quantitatively remove the lead peroxide (and as much of the fibrous media as possible) into a 250 ml beaker. Rinse plate thoroughly. Add 20 mls Na_2CO_3 and swirl gently to mix. Place beaker in a drying oven at 105°C until it evaporates to ± 25 ml. Filter solution through a Whatman #2 filter into a 50 ml volumetric. Rinse beaker several times and dilute sample to 50 ml with distilled water and mix. Exchange samples twice through clean Cation Resin.

Refer to Thorin Method and begin with PROCEDURE.

CALCULATIONS:

$$\frac{(\text{ppm of Std x aliquot})}{\text{mls BaCl}_2 - \text{Blk}} \times \frac{(\text{mls BaCl}_2 - \text{Blk})}{\text{Aliquot}} \times \text{dilution} \times$$

.667 (conversion factor of SO_4 to SO_2) = ug's SO_2 per exposed plate.

REFERENCES: Corning Laboratories Inc., "Procedure for Analyzing the Sulfate Content in Huey Sulfation Plates."

SULFATE

METHOD: Sulfate Impingers

REAGNETS: 0.04 Potassium Tetrachlormercurate - TCM

Dissolve 10.86 g. mercuric chloride, 0.066 g. EDTA, and 6.0 g. potassium chloride in distilled water and dilute to 1 liter.

CAUTION!! HIGHLY POISONOUS

(This reagent is stable for 6 months - if a precipitate forms, discard the reagent.)

PROCEDURE: Add 50 mls TCM to a red plastic test tube. Place the flow apparatus in place and cover orifices with Parafilm. Upon return to the laboratory, measure the volume of sample. Refer to Thorin Method for Sulfates and begin with Procedure.

CALCULATIONS:

$$\frac{\text{ppm of Std x aliquot}}{\text{mls } BaCl_2 - \text{Blank}} \times \frac{\text{mls } BaCl_2 - \text{Blank}}{\text{aliquot}} \times \text{Volume of Sample} \times .667 = SO_2/\text{sample}$$

REFERENCES: National Primary and Secondary Ambient Air Standards, Federal Register, 40 CFR 50; 41 FR 52686, December 1, 1976.

TRACE METALS

METHOD: Hi-Volume Samples, Whatman #41

REAGENTS: Conc. HNO_3, Conc, $HClO_4$

PROCEDURE: The part of the sample is digested in a 250 ml glass beaker with 60 mls HNO_3 and 10 mls $HClO_4$. Place on hot plate under fume hood, cover with watch glass and heat until perchloric fumes develop and sample turns colorless. Allow sample to cool and rinse cover glass with distilled water. Filter sample through a Whatman #2 into a 25 ml volumetric. Add 2.5 mls HNO_3 and dilute to volume with distilled water.

Sample is ready for Atomic Absorption Spectrometry.

CALCULATIONS:

$$\frac{\text{ug's}}{\text{ml}} \times \frac{\text{25 mls}}{\text{.5 (half a paper)}} = \frac{\text{ug}}{\text{ml}} \times \frac{\text{50 mls}}{\text{paper}} = \text{ug's/exposed paper}$$

ppm x 50 = ug's/exposed paper

REFERENCES:

1. National Primary and Secondary Ambient Air Standards, Federal Register, 4DCFR50, 41FR52686, December 1, 1976.
2. Standard Conditions, 1976, Perkin-Elmer, Analytical Methods for Atomic Absorption Spectrophotometry.
3. Operating Parameters, 1973, Perkin-Elmer, Analytical Methods Using H-GA Graphite Furnace.

TRACE METALS

METHOD: Precipitation Samples

REAGENTS: Concentrated Nitric Acid

PROCEDURE: Accurately measure the sample and record the volume in logbook. Transfer sample to a glass beaker and evaporate in an oven set @ 100° - 105° C to less than 25 mls. Filter sample through a Whatman #2 into a 25 ml volumetric. Add 2.5 mls HNO_3 and dilute to volume with distilled water.

Sample is ready for Atomic Absorption Sepectrometry.

CALCULATIONS: $\text{ppm} \div \left(\frac{\text{recorded volume}}{25}\right) = \text{ug's of metal/sample}$

REFERENCES:

1. Methods for Collection and Analysis of Water Samples for Dissolved Minerals and Gases. Book 5, Chapter A-1.
2. Standard Conditions, 1976, Perkin-Elmer, Analytical Methods for Atomic Absorption Spectrophotometry.
3. Operating Parameters, 1973, Perkin-Elmer, Analytical Methods Using H-GA Graphite Furnace.

PART II

METEOROLOGY/CLIMATOLOGY PARAMETER
and
DATA LOGGING SYSTEM

1.0 WIND SPEED SENSOR

A Model 010 Met One (TechEcology) lightweight, three-cup anemometer is used to monitor wind speed. The sensor utilizes a 40-slot light chopper disc that passes through a solid-state light source and detector. Amplified pulses are generated by the rotation of the chopper disc at a frequency which is proportional to the rotation rate of the anemometer cup assembly and to the wind speed measured. The wind speed sensor will be returned to the factory for maintenance and re-calibration at least once per year or when necessary. Extended bearing life and electronic dependability is afforded by a five-watt internal heater.

PERFORMANCE CHARACTERISTICS

Maximum Operating Range	0-60 meters/sec or 0-125 mph
Starting Speed	.2 meters/sec or 0.5 mph
Calibrated Range	0-50 meters/sec or 0-100 mph
Accuracy	±1% or 0.15 mph
Temperature Range	-50°C to +85°C
Response	Distance constant less than 5 feet* of flow

* The distance traveled by the air after a sharp edged gust has occurred for the anemometer rate to reach 63% of the new speed.

ELECTRICAL CHARACTERISTICS

Power Requirements	12 VDC at 10 MA
Output Signal	11-volt pulse
Output Impedance	100 ohms maximum
Internal Heater	12 VDC at 5 watts

PHYSICAL CHARACTERISTICS

Weight	1.5 lbs.
Finish	White glass baked enamel
Mounting Fixtures	Use with #C1120 Crossarm

2.0 HORIZONTAL WIND DIRECTION SENSOR

A Model 020 Met One (TechEcology) lightweight wind vane is used to monitor the horizontal wind direction. The wind vane is linked mechanically to a single low-torque, horizontal precision potentiometer with an output directly proportional to the azimuth wind direction. A constant input voltage is applied from a regulated power supply. Azimuth (360° or 540°) data is provided in the form of an analog signal proportional to the wind direction. The wind vane assembly will be returned to the factory for maintenance and recalibration at least once per year. Extended bearing life and electronic dependability is afforded by a five-watt internal heater.

PERFORMANCE

Azimuth	Electrical 0-356°*-Mechanical 0-360°
Threshold	0.6 MPH
Linearity	±½% of full scale
Accuracy	±3°
Damping Ratio	0.4 - 0.6
Delay Distance	Less than 3 feet

* 360° of 540° range is determined by the translator range card, not the wind direction transducer.

ELECTRICAL CHARACTERISTICS

Input Power	12 VDC at 10 MA
Output*	0-5 volts for 0-360° (or 540°)
Output Impedance	100 ohms maximum
Maximum Line Length	1500' (consult factory if longer line is to be used)
Internal Heater	12 VDC at 5 watts

MECHANICAL CHARACTERISTICS

Weight	1.5 lbs.
Finish	White gloss baked enamel

3.0 BIVANE WIND SENSOR

A Model 022 Met One (TechEcology) lightweight (horizontal and vertical) sensor is used to monitor the horizontal and vertical wind direction. The bivane sensor is connected directly to a single low-torque precision vertical potentiometer and mechanically linked to a single low-torque horizontal precision potentiometer. A constant input voltage is applied to the potentiometers from a regulated power supply. Individual potentiometer output signals are directly proportional to the vertical or horizontal wind direction providing either 360° or 540° azimuth and ±60° vertical data in analog form. The bivane sensor will be returned to the factory for repairs and re-calibration at least once per year. Extended bearing life and electronic dependability is afforded by an internal five-watt heater.

PERFORMANCE CHARACTERISTICS

Vertical Range	Electrical -60° to +60° Mechanical -60° to +60°
Azimuth Range*	Electrical 0-356° Mechanical 0-360° (continuous)
Threshold	0.6 MPH
Accuracy	
Vertical Range	±.6°
Horizontal Range	±3°
Linearity	±½% of full scale
Damping Ratio	0.4 to 0.6
Delay Distance	Less than 3 feet

* Either 360° or 540° output can be obtained when used with Tech Ecology line of signal translators.

ELECTRICAL CHARACTERISTICS

Vertical Output	0 to 5 VDC for ±60°
Horizontal Output	0 to 5 VDC for 0-360° (or 540°)
Sensor Input Power	12 VDC at 15 MA
Output Impedance	
Vertical	100 ohms maximum
Horizontal	100 ohms maximum
Maximum Line Length	1500 ft. (consult factory if longer line is used)
Internal Heater	12 VDC at 5 watts

MECHANICAL CHARACTERISTICS

Weight	1.5 lbs
Outside Finish	White gloss baked enamel
Mounting	Use with C1120 Crossarm Assembly

4.0 HEATED RAIN/SNOW GAUGE

A Model P511E Weathermeasure Corporation tipping bucket rain gauge is used to monitor total precipitation in either liquid or solid form. A low-frequency voltage output is generated when the liquid content in one of the two buckets is equal to the preset amount (.01 inches) and the bucket tips causing a mercury switch to make momentary contact. The second bucket is in the receiving position while the first bucket empties. Solid forms of precipitation are melted by electric heaters in the base and outer case of the instrument. Heaters are controlled termostatically between 0°C and 35°C. Calibration checks will be performed every three to six months to assure that the bucket tips are equal to the exact volume corresponding to the precipitation increment--.01 inches = 8.0 cubic centimeters.

PERFORMANCE CHARACTERISTICS

Orifice	20cm. (8 in.)
Calibration	0.01 in. or 0.25mm. (others on request)
Accuracy	0.5% (Calibrated at 0.5 in./hr.)
Sensor	Tipping Buckets - Chrome plated brass
Switch	Mercury
Heat Control	Thermostat adjustment, 0° to 35°C

ELECTRICAL CHARACTERISTICS

Power	110V a-c; 50/60 cycle; 500 watts
Output	±25V d-c, maximum pulse height

PHYSICAL CHARACTERISTICS

Outer Case	Plastic with brass orifice
Color	White
Bug Protection	Wire mesh at all openings
Size	9½ in. diameter x 18 in. high
Weight	20.5 lbs.

5.0 BAROMETER SENSOR

A Model B242 Weathermeasure Corporation analog output barometer sensor is used to monitor the absolute ambient barometric pressure in the millibars of mercury (mb Hg) column. The analog barometer sensor consists of a four-element aneroid cell coupled to the core of a linear variable differential transformer. Voltage output is proportional to the absolute pressure at the sensor location. The output signal is conditioned from a solid-state d-c amplifier to provide a 0 to 1.0 volt output over any 100mb interval from 600 to 1065mb. Calibration checks will be performed every two to four weeks to assure accuracy of the recorded pressure.

PERFORMANCE CHARACTERISTICS

Sensing elements	Aneroid cell with a linear variable differential transformer (LVDT)
Range	Any 100mb interval from 600 to 1065mb standard
Linearity	± .5mb (0.0 to 40°C) ±1.0mb (-20 to +40°C)
Operating temperature	-20 to 40°C

ELECTRICAL CHARACTERISTICS

Power	110V a-c; 50/60 cycle
Output	0-1V d-c; over a range of 100mb

PHYSICAL CHARACTERISTICS

Sensor housing size	7.5" high x 4.25" wide x 3.125" deep

6.0 SOLAR RADIATION SENSOR

A Model R413 Weathermeasure Corporation star pyranometer is used to monitor the total hemispherical (global) radiation at the earth's surface in langleys per minute (gm-cal cm^{-2} min^{-1}). The circular plate sensor is composed of 12 alternating black and white painted copper segments mounted beneath a hemispherical, ground and polished dome, 70mm in diameter. The temperature difference between the black and white segments is converted by thermocouples into a thermal-electric output of approximately 8mv/langley min^{-1}. Cosine response is within ±two percent from zenith to within 10° of the base of the dome. The sensor will be standarized at least once per year by comparison with an Eppley precision pyranometer or by returning to the factory for re-calibration.

PERFORMANCE CHARACTERISTICS

Spectral Response	.03 ≅ 3 microns
Sensitivity	8mV per gm-cal/cm^2/min
Calibration	gm-cal/cm^2/min
Instrument Orientation	Upward, downward, or side facing
Impedance	Approximately 35 ohms
Response Time	Approximately 50 sec. full scale
Sensing Element	6 black and 6 white segments with thermopile thermal contact
Thermopile	72 junctions CrNi-Constantan

ELECTRICAL CHARACTERISTICS

Output	0 - approximately 16mv

PHYSICAL CHARACTERISTICS

Dome	7cm (2-3/4") diameter ground crystal glass
Leveling	Adjusting legs and bull's eye level

7.0 TEMPERATURE AND DEW POINT SENSORS

The ambient temperature is monitored using a Climatronic Corporation No. 10093 thermilinear thermistor sensor. The sensor consists of a 6K ohm thermistor and a 30K ohm thermistor, which produce an output resistance proportional to the ambient temperature.

Thermistor Specifications

Range	34° to + 50°C
Accuracy	± 0.2°C
Time Constant	10 seconds to 63% (when used with the TS-10 shield)
Linearity	± 0.2°C
Size	¼ inch diameter x 4 inches long

The dew point temperature is monitored using a Climatronics Corporation Model DP-10 dew cell. The probe consists of a thermilinear thermistor mounted in a housing, a bobbin assembly, and a protective shield. The bobbin assembly consists of a spool wound with LiCl-inpregnated wicking on which gold bifilar electrodes are wound. As the LiCl absorbs moisture, the wicking becomes conductive and heat is generated when a voltage is supplied to the electrodes. When the vapor pressure of the LiCl equals the water vapor pressure of the surrounding air, equilibrium is reached, and the corresponding resistance of the thermistor is proportional to the dew point temperature.

Dew Cell Specifications

Range	-40° to 42°C (dew point)
Accuracy	±0.5°C
Response Time	1.0°C/minute
Power	11.5V a-c, 50/60 cycles

A Climatronics Corporation Model T5-IOWA motor aspirated temperature shield and dew cell aspirated shield house both the thermistor and dew cell sensors. The shield is designed to continuously sample the ambient air without effects of solar radiation.

Aspirator Shield Specifications

Operating range	-54° to +66°C
Error	0.2°C or less under radiation of 1.6 langleys/min^{-1}.
Overall length	42 inches

The thermistor will be standardized at least every six to twelve months using an ice and/or hot bath. The dew cell will be standardized at least every six to twelve months using a standard sling psychrometer.

8.0 ACOUSTIC RADAR

The acoustic radar emits a sound pulse upward and then listens for the echo which comes back from turbulence regions aloft. It plots the echo region by means of a stylus which moves across a recording chart, with the stylus position representing echo height. The transmit-receive-record sequence is repeated every few seconds providing a continuous picture of atmospheric conditions passing over the system. The AeroVironment Model 300 Monostatic Acoustic Radar emits a 1600 Hz pulse (selectable from 50 to 200msec duration). The stylus moving across the chart darkens the paper when an echo is received. Chart speed is 1.2 inches per hour. The altitude scale may be selected at 750 or 1500m. Our system includes the transmit-receive antenna, the transceiver-display unit, which houses the stylus, chart, and electronics, and an eight-foot high pentagonal structure lined with acoustical foam (to supress ambient noise) that surrounds the antenna. The air pollution engineer/meteorologist can use the system to study the varying capability of the atmosphere to mix pollutants, to validate dispersion models, to assess the suitability of a new site for an industrial plant, and to support his interactions with regulatory agencies.

PERFORMANCE CHARACTERISTICS

Transmit Signal	
Frequency	1600 Hz
Pulse duration	Switchable, 50, 100, 200msec
Transmit power	100 watts
Recorder	
Writing technique	Electric on conducting chart paper
Chart Size	15.2cm x 22 meters long
Chart Speed	30.5mm per hour
Chart duration	28 days, continuous operation

ELECTRICAL CHARACTERISTICS

Voltage	115V a-c
Frequency	60 Hz
Power	50 watts
Sound level transmittal	Less than 60 dB at 10m
Sounding ranges	750/1500m

PHYSICAL CHARACTERISTICS

Antenna Assembly	133cm diameter 80cm high
Transceiver Unit	
Width	44.5cm
Height	44.5cm
Depth	22cm
Weight	
Antenna	26 kg
Transceiver	20 kg

9.0 ALDEN FACSIMILE RECORDER

The Alden Model 9271H recorder automatically starts from signals received over the National Weather Service (NWS) NAFAX circuit and is used to produce paper copy facsimiles of weather maps sent over the NWS circuits. A time clock is used to obtain the desired maps and to reject all others. The weather maps generated by the unit are used to formulate air quality forecasts and to provide a reference library of weather conditions, which occurred during particular stagnation events, and for correlation with standard air quality monitoring equipment information. Currently, several maps are received daily. They are as follows:

500mb Analysis 0000 and 1200 GMT
700mb Analysis 0000 and 1200 GMT
850mb Analysis 0000 and 1200 GMT
Barotropic Prognosis - 500mb heights and vorticity for 12, 24, and 36 hr.
Radar Summary
LFM (Limited Fine Mesh) prognoses for 24, 36, and 48 hr. for 500mb heights and vorticity
Weather depiction
Surface analysis 0000, 0600, 1200, 1800 GMT
GOES Satellite Western U.S.
12-and 24-hour clouds, precipitation, and low level significant weather prognosis
36-and 48-hour surface, clouds, and precipitation prognosis
Precipitation probability prognosis
Maximum/minimum temperatures prognosis
30-hour surface and 36-hour 1000-500mb thickness prognosis
72-hour 500mb prognosis

Service A Teletype

Negotiations are under way to obtain a Service A Teletype which receives hourly weather data and forecasts for the western U.S.

10.0 DATA LOGGING SYSTEM

A Campbell CR5 data logging system is used for recording all meteorological/climatological data and will be used for continuous analyzer parameters such as SO_2 and NO_2. The system is capable of 1) making integrated measurements for a five-minute time interval and comparing the results with hand-made measurements of the same parameter to verify correct operation of the system and then switching to a longer time interval without affecting the calibration and 2) integrating data over time periods up to 24 hours without drift errors.

Each CR5 module includes a binary counter for accumulating pulses from the input or from the voltage to frequency converter used in A/D conversion. With integrating or pulse-counting modules, the binary counter is counting during the entire time between scans. The sampling modules use a single binary counter for several channels. This counter accumulates counts from a V/F converter for exactly .3 seconds. Then the count is transferred to the control module and to the printer during the next .3 seconds. The following channel then is read out using the same counter. For sampling several voltages, this approach uses common signal conditioning and A/D conversion for several channels.

The CR5 includes signal conditioning and A/D conversion in each input module. During the scan, digital information is transferred from the input module to the control module and then to the printer or other recording devices.

A microprocessor module allows for integrated values of wind speed, wind direction (100 samples/minute), standard deviation (σ) for horizontal and vertical wind directions, and precipitation for time scans down to 0.6 seconds.

An Audio Cassette tape interface module (R235) provides the means to store data from the CR5 Digital Recorder on standard audio cassettes. When connected to an audio cassette tape recorder, the R235 accumulates blocks of data in its memory, and when full it automatically switches on the recorder and dumps the buffered data over the "mic" line to the recorder.

Characters are coded on the tape in a bit serial ASCII code with the data blocked in variable length records up to 500 characters per block. The ASCII character for line feed is automatically put on the tape by the R235 module after each ten channels of data and at the end of each scan. This provides a readable data format on the terminal during input of the data via the A235 module which is interfaced to the Data General Eclipse C-330 computer.

PART III-A

DATA HANDLING SYSTEM
and
COMPUTER INTERFACE

1.0 INTRODUCTION

The meteorological data handling system (MDHS) was proposed as a means of gathering, storing, and manipulating meteorological data obtained from remote monitoring sites in the Butte area. The system 1) allows relatively easy transfer of the data from cassette tapes to disc files on the Montana Energy and MHD Research and Development Institute (MERDI) computer system, 2) provides data checking and editing capabilities, 3) allows easy access to the data base as needed for report generation, and 4) provides a means of storing the data on both a short- and long-term basis.

2.0 SUMMARY

As the meteorological data is gathered by the instrumentation at the sites, it is printed out simultaneously on paper tape and stored on a magnetic cassette tape, which is changed approximately once per week. The data from the magnetic tape is transferred to disc files on MERDI's computer via an audio-digital interface connected directly to MERDI's computer.

The first step in transferring the data consists of transferring the data from the tape to a temporary disc file. The data in the temporary file then is printed out on the line printer to find and correct any errors resulting from the data transmission. At that time, the data in the temporary file is checked against the printout on the paper tape for completeness and correctness. Once the temporary data file has been checked and corrected, the data is added to the appropriate permanent meteorological data file.

3.0 PROGRAMS

3.1 Input

The data from the cassette tape is transferred from the magnetic tape to a user-named temporary disc file using a program called TAPIN. As the data is being transferred, it also is printed out on the screen for visual reference. TAPIN is used to read the tapes from both the permanent meteorological station and the remote station at Paxson-Terre Verde (see Figure 1).

```
) X TAPIN

INPUT FILE NAME (6 CHAR MAX)? PAX 4
00+T17 01+T12 02+T00 03+035 04+010 05+003 06+001 07+002 08+014 09+190
10+037 11+011 12-144 13-048 14+000

00+T17 01+T13 02+T00 03+038 04+013 05+009 06+001 07+000 08+007 09+183
10+048 11+013 12-139 13-043 14+000

00+T17 01+T14 02+T00 03+002 04+001 05+001 06+005 07+008 08+011 09+159
10+288 11+019 12-097 13-082 14+000
```

Note: User inputs underlined

Figure 1.--Example of Cassette Tape Input to Computer File PAX 4

When all of the data has been entered, the user closes the temporary file by depressing the "CONTROL" and "D" buttons, simultaneously.

3.2 Verification and Editing

Once the data has been entered, a hard copy of what is in the temporary file is generated on the line printer by typing the system command , QPRINT, followed by the file name on the computer console (see Figure 2).

```
                              STOP TAPIN
                            ) QPRINT PAX 4
```

Note: User inputs underlined.

Figure 2.--Example of Command to Output a Disk File (PAX 4) to the Line Printer

The hard copy then is checked visually for invalid characters (e.g., ?, B, etc.), missing scans, etc. If the data is incomplete or not accurate, the printout from the line printer is checked against the printout of the data on the paper tape, and any discrepancies are noted on the temporary file's printout. Should editing of the temporary data file be necessary, the system program "LINEDIT" is used as shown in Figure 3.

```
) X LINEDIT PAX 4

      . . . . . . .BUILDING ED DESCRIPTOR FILE. . . . . . .

?SET LINE
?FIND '01+T00'

LINE 170
170 00+T21 01+T00 02+T00 03+000 04+001 05+002 07+001 08+004 09+194

?SUB '00+T20 01+T24' FOR '00+T21 01+T00' IN 170
170 00+T20 01+T24 02+T00 03+000 04+001 05+002 06+002 07+001 08+004 09+194

?FIND '01+T00'

LINE 218
218 00+T22 01+T00 02+T00 03+001 04+001 05+009 06+004 07+001 08+010 09+007

?SUB '00+T21 01+T24' FOR '00+T22 01+T00' IN 218
218 00+T21 01+T24 02+T00 03+001 04+001 05+009 06+004 07+001 08+010 09+007

  ? BYE
DO YOU WANT TO SAVE THE ORIGINAL FILE AS A BACKUP FILE?  N

                    FILE PAX 4 BEING UPDATED
```

Note: User input underlined.

Figure 3.--Example of Method Used to Edit Temporary Data File

3.3 Input of Data to Permanent Data File

Once the temporary file has been checked and/or corrected, the data is added onto the permanent disc file using one of two programs, depending on which station the data is from.

3.3.1 Input of Paxson Station Data

The first step in adding to the permanent data file is to rename the permanent file temporarily and run the temporary data file through the file build routine as a final check of the data (see Figure 4).

```
) RENAME PAXSON. DA PAX. DA

) X PAXDAT

  STOP PAXDAT

) X PAXBLD

  NO. OF MONTH OF FIRST SCAN?  11
INPUT FILE NAME?  PAX 4
  STARTING AT RECORD        0+1
  ENDING AT RECORD      124
TRANSFER COMPLETE
PROCESS ANOTHER INPUT FILE (Y OR N)?  N
STOP NORMAL
```

Note: User inputs are underlined.

Figure 4.--Example of Command Sequence Used to Preprocess Meteorological Data

As shown in Figure 4, this is done by using the command "RENAME" to change the permanent file name, PAXSON. DA, to some temporary file name. The routine PAXDAT then is executed to recreate PAXSON. DA and fill in the header data (station location, elevation, and record count). PAXBLD then is used to fill in the remaining records of PAXSON. DA using the temporary file (in this case, PAX 4).

The next step is to use the routine PAXOUT to list out the data in PAXSON. DA either on the console or on the line printer (see Figure 5). The user then can check the printout for values of -10000 (invalid or out-of-limits data) or -20000 (invalid data due to unrecognizable characters). Should either or both values appear on the printout, the user can check the original printout of PAX 4 to validate or correct any remaining errors. The user then can use LINEDIT to edit the temporary file and repeat the above process.

```
) X PAXOUT
  LINEPRINTER (0) OR CONSOLE (1)?  1
  ALL (0) OR PARTIAL (1)?  0

1 11177 1200 35 10 4 1 2 10 0826 317 15 -141 -48 0
2 11177 1300 38 13 3 1 2 14 8196  37 11 -144 -46 0
3 11177 1400 36  9 9 1 0 12 8183  48 13 -144 -41 0
                     :
                     :

STOP PAXOUT

Note:  User inputs underlined.
```

Figure 5.--Example of Command Sequence Used to Output Contents of Permanent Meteorological Data File

Once the final check of the temporary file has been successfully completed, the user is ready to enter the data contained in the temporary file into the permanent file as shown in Figure 6.

```
) DELETE/V PAXSON.DA
  DELETED PAXSON.DA
  ) RENAME PAX.DA PAXSON.DA
  ) X PAXBLD
    NO. OF MONTH OF FIRST SCAN?  11
  INPUT FILE NAME?  PAX 4
    STARTING AT RECORD      496+1
    ENDING AT RECORD     620
  TRANSFER COMPLETE
  PROCESS ANOTHER INPUT FILE (Y OR N)?  N
  STOP NORMAL

) X PAXOUT
  LINE PRINTER (0) OR CONSOLE (1)?  0
  ALL (0) OR PARTIAL (1)?   1
  STARTING RECORD NUMBER?  497
  ENDING RECORD NUMBER?  620
STOP PAXOUT
)
```

Figure 6.--Example of Command Sequence Used to a New Meteorological Data to the Permanent Data File

First, the file PAXSON.DA is deleted (it contains the data that was just used as a final error check). Second, the permanent file is renamed back to PAXSON.DA. Third, PAXBLD is executed to add the data in PAX 4 to the permanent file. Finally, PAXOUT is used to generate a printout of the newly added records on the line printer for documentation purposes.

3.3.2 Input of Permanent Meteorological Station Data

The input of the data from the permanent meteorological station follows the same procedure as described above with the following exceptions.

- The permanent data file is named PRMET.DA.
- METBLD is used to add the new data to the permanent data file.
- METDAT is used to recreate PRMET.DA for the final error checking.
- METOUT is used to output the contents of PRMET.DA for checking and documentation.

Different programs are used for inputting permanent meteorological station data because of the difference in the channel designations and the amount of channels used at the station versus the PAXSON station.

3.4 Reports

Two different programs are used to output the data depending on which station the data is from.

3.4.1 Output of Paxson Data

The data for the Paxson station is output on a daily basis using the program PAXRPT. The report contains the station name, the station location, and the station elevation plus the amount of solar radiation (ly/min.), the temperature (°C), the dew point temperature (°C), precipitation (mm), the barometric pressure (mb Hg), the integrated wind direction (degrees azimuth), the integrated wind speed (m/s), the resultant wind speed (m/s), the instantaneous wind direction (degrees azimuth), the instantaneous wind speed (m/s), and the magnitude of wind direction fluctuations, sigma, (degrees azimuth) on an hourly basis (based on a 24-hour clock). In addition to the above, the report also gives 1) daily totals for solar radiation (ly/day) and precipitation (mm), 2) daily averages for solar radiation (ly/min.), temperature (°C), dew point temperature (°C), barometric pressure (mb Hg), integrated wind speed (m/s), resultant wind speed (m/s), instantaneous wind speed (m/s), and sigma (degrees azimuth), 3) standard deviation values for the data points listed in 2 above, 4) the daily wind rose in percentage of time for wind speeds both above and below 4 m/s in a given direction, and 5) the percentage of time the wind was calm (<0.5 m/s).

3.4.2 Output of Permanent Meteorological Station Data

Data for the permament meteorological station data is output on a daily basis using the program METRPT. The report format has not been finalized, but it will be similar to the daily Paxson report. The report contains essentially the same data as the Paxson report with the addition of temperature at the 10 and 40m level (°C), amount of evaporation (mm), wind direction at the 10 and 40m level (degrees azimuth), wind speed at the 10 and 40m level (m/s), sigma at the 10 and 40m level, vertical wind direction at the 40m level, vertical sigma at the 40m level, and the maximum gust at the 10 and 40m level.

3.5 Data File Manipulation

Support programs are being written as needed to output the contents of each permanent data file, to allow editing of the permanent data files, and to transfer the permanent data files to magnetic tape for long-term storage.

4.0 DATA FILES

Two different data files are used due to the differences in the instrumentation and the amount of data gathered at the two stations. Future efforts will be made to alleviate any differences in channel designations and the amount of data collected at the stations. This will help standardize data gathering and input procedures.

4.1 PAXSON.DA

The data from the remote monitoring station at Paxson's (south of Butte) is stored in a randomly organized file containing records that are fourteen words long as shown below. The first record (number 0) contains the number of records in the file, the station name, and the station location and its elevation. The remaining records are stored chronologically and contain the following information:

File: PAXSON.DA

WORD	DESCRIPTION	COMMENT
1*	Date	MMDDY
2	Time	HHMM
3	Solar Radiation	ly/min.
4	North Wind Component	
5	East " "	
6	South " "	
7	West " "	
8	Total " "	
9	Barometric Pressure	mb Hg
10	Instantaneous Wind Direction	degrees azimuth
11	Instantaneous Wind Speed	meters/sec.
12	Dew point Temperature	°C
13	Ambient Air Temperature	°C
14	Precipitation	Inches

* The first word of record 0 contains the number of records in file. Words 2-4 (inclusive) contain station name (i.e., "Paxson"). Words 5-10 (inclusive) contain station location (e.g., 020N7W18ACCD). Word 11 contains station elevation in meters (e.g., 1237).

4.2 PRMET.DA

The data from the permanent monitoring station is stored in a randomly organized file containing records that are nineteen words long as shown below. The first record (0) contains the number of records in the file, the station names, the station location, and the station elevation. The remaining records are stored chronologically and contain the following information:

File: PRMET.DA

WORD		DESCRIPTION	COMMENT
1*		Date	MMDDY
2		Time	HHMM
3		ASP Motor	
4		Barometric Pressure	mb Hg
5		Dew Point	°C
6		Lower Temperature	°C
7		Upper Temperature	°C
8		Evaporation	inches
9		Open	Reserved
10		Solar Radiation	ly/min
11		Precipitation	inches
12		Integrated Horizontal Wind Direction	degrees azimuth
13	@10m level	Integrated Horizontal Wind Speed	m/sec
14		Sigma--Horizontal	degrees azimuth
15		Integrated Horizontal Wind Direction	degrees azimuth
16		Integrated Horizontal Wind Speed	m/sec
17		Sigma--Horizontal	degrees azimuth
18	@40m level	Integrated Vertical Wind Direction	degrees
19		Sigma--Vertical	degrees

* The first word of record 0 contains the number of records in file. Words 2-4 contain the station name (i.e., "PRMET"). Words 5-10 contain station location (e.g., 020N7W18ACCD). Word 11 contains station elevation in meters.

PART III-B

DATA HANDLING SYSTEM
and
COMPUTER INTERFACE

1.0 INTRODUCTION

The air quality data handling system (AQDHS) has been proposed as a means of storing, manipulating, and reporting air quality data (gathered as a result of the air quality portion of Task Q currently being undertaken by The Montana Energy and MHD Research and Development Institute--MERDI--personnel) in a centralized, easily accessible, and meaningful manner.

2.0 SUMMARY

Air quality data is being gathered at one permanent and one mobile site located south-southeast of the MHD CDIF site. The data is obtained by analyzing samples collected by dustfall sampling, precipitation washout sampling, high-volume air sampling (using Whatman #41 and fiberglass filters), static air sampling techniques, and impinger sampling.

Once the analytical results are obtained, they are entered onto the appropriate data sheets along with other pertinent information concerning the site. The data from the data sheets then is added to the appropriate data files on MERDI's computer via one of the computer consoles.

3.0 FACILITIES

Air quality data is entered into files in MERDI's Data General Eclipse C330 computer system via one of the Data General Model 6053 CRT terminals. Report and file listings are being generated on the Data General Model 4215 line printer. Short-term storage consists of files on the 96 MB disc pack, and long-term storage will be on magnetic tape.

4.0 PROGRAMS

4.1 Input

There is one data entry program per data type (i.e., one program for dustfall sample data, one for high-volume air samples from the Whatman #41 filter, and one for high-volume air samples from the fiberglass filter, etc.). Each program prompts the user to enter data in the same sequence and form as on the data sheet (see Figure 1).

```
) X HIFB
 *** HI-VOL AIR SAMPLING DATA ENTRY PROGRAM-FIBERGLASS FILTER ***
 ENTER DATA AS INDICATED

 STATION ID NO.? 1
 ENTER DATE (EX. 8/25/77)  11/29/77
 FILTER NO.?  10002
 Q STD? 14.75
 INITIAL TIME READING?  124.5
 FINAL TIME READING?  2367.8
 TOTAL PARTICULATE WEIGHT (MG/PAPER)?  2.375
 VERIFY INPUTS (0=NO  1=YES)?     0
 DO YOU WANT TO ENTER MORE DATA (0=NO  1=YES)?  0
STOP HIFB
```

Note: User required inputs are underlined

Figure 1.--Example of Data Entry for High-Volume Fiberglass Filter Data

As the data from each particular data sheet is entered, it is checked for validity and completeness. If an input error is detected, a descriptive error message is output to the terminal to alert the user, who then can re-enter the correct data (see Figure 2).

```
) X HIFIB
 *** HI-VOL AIR SAMPLING DATA ENTRY PROGRAM-FIBERGLASS FILTER ***
 ENTER DATA AS INDICATED

 STATION ID NO.?  1
 ENTER DATE (EX. 08/25/77) 11/09/76
 INVALID YEAR ENTERED
 ENTER DATE (EX. 08/25/77)  11/29/77
 FILTER NO.? 10001
 Q STD? -14.75
 INVALID NUMBER
 Q STD? 0
 INITIAL TIME READING?  -10
 INVALID NUMBER
 INITIAL TIME READING?  100.75
 FINAL TIME READING?  300.65
 TOTAL PARTICULATE WEIGHT (MG/PAPER)?  0.28
 VERIFY INPUTS (0=NO  1=YES)?  0
 DO YOU WANT TO ENTER MORE DATA (0=NO  1=YES)?  0
STOP HIFIB
```

Note: User inputs are underlined.

Figure 2.--Example of Error Messages and Corrections on Data Entry

Once all of the data from one data sheet has been entered, the user has the option of verifying the data which was just entered or not. If the user chooses not to verify the data, the data file is updated, and the user then can enter more data from another data sheet or stop (see Figure 1). If the user selects to verify inputs, the data that was just entered will be output to the screen so that the user can check the input values against those on the data sheet (see Figure 3).

```
) X HIFIB
 *** HI-VOL AIR SAMPLING DATA ENTRY PROGRAM-FIBERGLASS FILTER ***
 ENTER DATA AS INDICATED

 STATION ID NO.?  1
 ENTER DATE (EX. 08/25/77)  11/29/77
 FILTER NO.?  10002
 Q STD?  14.5
 INITIAL TIME READING?  99376.75
 FINAL TIME READING?  100.5
 TOTAL PARTICULATE WEIGHT (MG/PAPER)?  2.56
 VERIFY INPUTS (0=NO  1=YES)?  1
```

```
STATION ID NO. =  1
DATE IS  11/29/77
FILTER NO. =  10002
Q STD = 0.145000E    2
INITIAL TIME = 0.993767E    5
FINAL TIME = 0.100500E    3
TOTAL PARTICULATE WEIGHT (MG/PAPER) =     0.256000E    1
ANY CHANGES (0=NO  1=YES)?  1
```

Note: User inputs underlined.

Figure 3.--Example of Verification of Data Just Input

If the user finds that he entered an incorrect value, he may change it by selecting a number corresponding to the datum from a menu and entering the correct value. If no changes are needed or once all changes have been made, the data file is updated, and the user is allowed to enter more data or stop (see Figure 4).

```
) X HIFIB
  *** HI-VOL AIR SAMPLING DATA ENTRY PROGRAM-FIBERGLASS FILTER ***
  ENTER DATA AS INDICATED

  STATION ID NO.?  1
  ENTER DATE (EX. 08/25/77)  11/29/77
  FILTER NO.?  10002
  Q STD?  14.5
  INITIAL TIME READING?   99376.75
  FINAL TIME READING?   100.5
  TOTAL PARTICULATE WEIGHT (MG/PAPER)?   2.56
  VERIFY INPUTS (0=NO  1=YES)?  1
  STATION ID NO.=     1
  DATE IS  11/29/77
  FILTER NO.=  10002
  Q STD =  0.145000E     2
  INITIAL TIME =   0.99376E      5
  FINAL TIME =  0.100500E    3
  TOTAL PARTICULATE WEIGHT  (MG/PAPER) =   0.25600E     1
  ANY CHANGES (0=NO  1=YES)?    1
  SELECT CHANGE AS INDICATED
  1 = STATION ID NO.
  2 = DATE
  3 = FILTER NO.
  4 = Q STD
  5 = INITIAL TIME READING
  6 = FINAL TIME READING
  7 = TOTAL PARTICULATE WEIGHT
  CHANGE NO.?  4
  Q STD?  14.75
  ANOTHER CHANGE (0=NO, 1=YES, 2=PRINT LIST + CHANGE)?  0
  VERIFY INPUTS (0=NO  1=YES)?  0
  DO YOU WANT TO ENTER MORE DATA (0=NO  1=YES)?  0
 STOP HIFIB
```

Note; User inputs are underlined.

Figure 4.--Example of Verification and Correction of Data Just Entered

4.2 Data File Manipulation

Support programs are being written as needed to output the contents of each data file to the line printer, to allow editing of data within the data file, and to transfer the data file to magnetic tape in order to guarantee the data file's integrity and long-term usefulness.

4.3 Reports

Programs to manipulate and combine the air quality data with selected meteorological data for reports are being developed. Report formats are being experimented with in an effort to combine as much useful data as possible in a single page of printout.

.0 DATA FILES

There is one file per data type, and each file contains randomly organized records. Each record contains the data from one data sheet as shown in the following sections.

In all of the data files, the following holds true:

- The first word of record number zero contains the number of records in the file.
- Values on the data sheets which are less than some detection limit (e.g., <0.01) are entered as negative values of the detection limits (e.g., <0.01 is entered as -0.01).
- A value of -1 is entered and stored if no test was made for the given trace element.
- A value of -2 is entered and stored if no scheduled test was run for the given trace element due to filter failure.
- A value of -3 is entered and stored if no scheduled test was run for a given trace element due to equipment failure.
- A value of -4 is entered and stored if no scheduled test was run for a given trace element due to insufficient sample amount.
- Real numbers are broken down into two integer words for storage in the file and rebuilt for reports using the subroutine RELNM.

```
                Call RELNM ( IARY, FLPTNM, IEXP, IFLAG)

      where     IARY is a two-element integer array,
                FLPTNM is the floating point value,
                IEXP is the power of ten to be used for conversion,
      and       IFLAG is an indicator.
                    =1  break up FLPTNM and store in IARY
                    =2  build FLPTNM from IARY.
```

5.1 Dustfall Data File

The data file for dustfall sampling data consists of records which are 66 words long. Each record contains the station ID number, the sampling date, the number of exposure days, and the concentrations of solubles, insolubles, total particulates, Al, As, B, Be, Benzene solubles, Bi, Ca, Cd, Cl, Co, Cr, Cu, F, Fe, Hg, K, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, SO_4, Sn, V, and Zn as shows in Figure 5.

File: DUST. DA

MWP
10/3/77

Word	Description	Comments
1	Station ID number	(0-7)
2	Sampling month	mm
3	Sampling year	yy
4	Number of exposure days	
5-6	Concentration of solubles	mg/jar
7-8	Concentration of insolubles	mg/jar
9-10	Concentration of total particulates	mg/jar
11-12	" " Al	μg/jar
13-14	" " As	"
15-16	" " B	mg/jar
17-18	" " Be	μg/jar
19-20	" " Benzene Sol	mg/jar
21-22	" " Bi	μg/jar
23-24	" " Ca	"
25-26	" " Cd	"
27-28	" " Cl	"
29-30	" " Co	"
31-32	" " Cr	"
33-34	" " Cu	"
35-36	" " F	"
37-38	" " Fe	"
39-40	" " Hg	"
41-42	" " K	"
43-44	" " Mg	"
45-46	" " Mn	"
47-48	" " Mo	"
49-50	" " Na	"
51-52	" " Ni	"
53-54	" " Pb	"
55-56	" " Sb	"
57-58	" " Se	"
59-60	" " SO_4	"
61-62	" " Sn	"
63-64	" " V	"
65-66	" " Zn	"

Figure 5.--Example of Data File for Dustfall Sampling Data.

5.2 High-Volume Air Sampling Data File (Fiberglass Filter)

The data file for the high-volume air sampling data using the fiberglass filter consists of records which are ten words long and contain the station identification number, the date, the filter number, the standard value for Q, the initial time counter reading, the final time counter reading, and the total particulate weight as shown in Figure 6.

File: HIFIB.DA

MWB
10/1/77

Word	Description	Comments
1	Station ID Number	0-7
2	Date	MMDDY
3	Filter Number	
4-5	Q_{std}	
6-7	Initial Time (t_i)	
8-9	Final Time (t_f)	
10-11	Total particulate weight	mg/paper

Figure 6.--Example of Data File for High-Volume Air Sampling Data.

5.3 High-Volume Air Sampling Data File (Whatman #41 Filter)

The data file for the high-volume air sampling data using the Whatman #41 filter consists of records which are 67 words long and contain the same data as the high-volume air sampling data file for the fiberglass filter plus the concentrations of Al, As, B, Be, Benzene solubles, Bi, Ca, Cd, Cl, Co, Cr, Cu, F, Fe, Hg, K, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Sn, SO_2, V, and Zn as shown in Figure 7.

File: HVWHT.DA

MWB
10/3/77

Word	Description	Comments
1	Station ID Number	0-7
2	Date of Sample	MMDDY
3	Filter Number	
4-5	Q_{std}	
6-7	Initial Time (t_i)	
8-9	Final Time (t_f)	
10-11	Total Particulate Weight	mg/paper
12-13	Concentration of Al	µg/paper
14-15	" " As	"
16-17	" " B	"
18-19	" " Be	"
20-21	" " Benzene Sol	"
22-23	" " Bi	"
24-25	" " Ca	"
26-27	" " Cd	"

Word	Description	Comments
28-29	Concentration of Cl	µg/paper
30-31	" " Co	"
32-33	" " Cr	"
34-35	" " Cu	"
36-37	" " F	"
38-39	" " Fe	"
40-41	" " Hg	"
42-43	" " K	"
44-45	" " Mg	"
46-47	" " Mn	"
48-49	" " Mo	"
50-51	" " Na	"
52-53	" " Ni	"
54-55	" " Pb	"
56-57	" " Sb	"
58-59	" " Se	"
60-61	" " Sn	"
62-63	" " SO_2	"
64-65	" " V	"
66-67	" " Zn	"

Figure 7.--Example of Data File for the High-Volume Air Sampling Data Using Whatman #41 Filter

5.4 Precipitation Washout Data File

The data file for precipitation washout sampling data consists of records which are 53 words long and contain the station identification number, the starting and ending date of the sample period, the starting and ending time of the sample period, the date and time the sample was collected, the field temperature and pH of the sample, the amount of precipitation collected during the sample period, the volume of sample taken, the concentrations of acidity and Al, As, Ca, Cd, Cl, Co, Cu, F, Fe, K, Mn, Na, Ni, NO_3, Pb, PO_4, SO_4, and Zn as shown in Figure 8.

File: PRECP.DA

MWP
10/4/77

Word	Description	Comments
1	Station ID Number	0-7
2	Starting date of sample period	MMDDY
3	Ending date of sample period	MMDDY
4	Starting time of sample period	HHMM
5	Ending time of sample period	HHMM
6	Date sample was collected	MMDDY
7	Time sample was collected	HHMM
8-9	Field temperature of sample	°C
10-11	Field pH of sample	1-14
12-13	Amount of precipitation collected	inches

Word	Description	Comments
14-15	Volume of sample	ml
16-17	Acidity concentration	ppm
18-19	Concentration of Al	"
20-21	" " As	"
22-23	" " Ca	"
24-25	" " Cd	"
26-27	" " Cl	"
28-29	" " Co	"
30-31	" " Cu	"
32-33	" " F	"
34-35	" " Fe	"
36-37	" " K	"
38-39	" " Mn	"
40-41	" " Na	"
42-43	" " Ni	"
44-45	" " NO_3	"
46-47	" " Pb	"
48-49	" " PO_4	"
50-51	" " SO_4	"
52-53	" " Zn	"

Figure 8.--Example of Data File for Precipitation Washout Sampling Data

5.5 Static Air Data File

The data file for the static air sampling data consists of records which are 12 words long and contain the station identification number, the sampling date, the number of exposure days, and the concentrations of SO_2, NO_2, fluoride from calcium formate, and fluoride from sodium formate as shown in Figure 9.

File: STATC.DA

MWP
10/4/77

Word	Description	Comments
1	Station ID number	0-7
2	Sampling month	MM
3	Sampling year	YY
4	Exposure days	
5-6	Total SO_2 concentrations	µg/plate
7-8	Total NO_2 concentrations	"
9-10	Fluoride from Ca formate	"
11-12	Fluoride from Na formate	"

Figure 9.--Example of Data File for Static Air Sampling Data

5.6 Ambient Impinger Data File

The data file is being developed.